6. Using MBSE to Understand the Link between Capability Acquisition Projects and DSTO Technology Advice

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Abstract

One role performed by technology Groups within DSTO is the provision of whole of platform advice to Defence capability acquisition projects during the needs and requirements phases of the capability development lifecycle. At present the process, or system, that links the request for advice from a capability acquisition project stakeholder to the analysis and advice provided by DSTO, is not clearly understood or defined. This lack of clarity can influence the form and content of the advice provided by permitting misinterpretation of the intended purpose of the advice by the DSTO Groups and/or misunderstanding on the part of the capability stakeholders as to the type of analysis required and the expected bounds of validity of the advice. The role that DSTO provides to the greater Defence organisation is analogous to many customer / service provider relationships in industry, thus this lack of clarity between customer requirements and technical advice provided is broadly applicable.

In order to gain a better appreciation of the process of linking requests for advice to analysis, two main aspects need to be considered, one that resides at the Group level and the other at the enterprise level. The enterprise level considers the wider provision of advice to Defence acquisition projects by DSTO. At this level, the problem is ill-structured and contains a multitude of stakeholders. A soft systems approach is one method that could be beneficial in enhancing our understanding and helping to define the system at this level. This presentation, however, focuses on the Group level. At this level, the problem is somewhat simplified due to the reduction in stakeholders, processes, analysis tools and techniques, nonetheless, the problem space is still non-trivial. It is anticipated that by defining the system at the Group level, a more informed subsequent exploration of the enterprise level could be conducted.

To address the problem at the Group level, a systems engineering approach has been deemed as suitable. This is based on the authors' contention that the problem at hand (i.e. the provision of advice due to a request) can be described as being an assemblage of elements, in the form of related activities and processes that form a unitary whole, where this unitary whole constitutes a system[2]. In this instance, an Object-Oriented Systems Engineering Method (OOSEM) approach[3], along with ISO15288, has been adapted and adopted to the development of a system for providing advice to stakeholders by the appropriate Groups within DSTO.

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[2] Blanchard, B. S. and Fabrycky, W. J. (2006) *Systems Engineering and Analysis. 4th ed*. New Jersey, Pearson Prentice Hall

[3] 2. Friedenthal, S., Moore, A. and Steiner, R. (2009) *A Practical Guide to SysML: The Systems Modeling Language*. Burlington, MA, Morgan Kaufmann OMG Press

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14. ABSTRACT
One role performed by technology Groups within DSTO is the provision of whole of platform advice to Defence capability acquisition projects during the needs and requirements phases of the capability development lifecycle. At present the process, or system, that links the request for advice from a capability acquisition project stakeholder to the analysis and advice provided by DSTO, is not clearly understood or defined. This lack of clarity can influence the form and content of the advice provided by permitting misinterpretation of the intended purpose of the advice by the DSTO Groups and/or misunderstanding on the part of the capability stakeholders as to the type of analysis required and the expected bounds of validity of the advice. The role that DSTO provides to the greater Defence organisation is analogous to many customer / service provider relationships in industry, thus this lack of clarity between customer requirements and technical advice provided is broadly applicable.

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This presentation will cover the exploratory research and concept stages of the development of a system for providing advice and how the DSTO Naval Architecture and Platform System Analysis Group and the Weapons Capability Analysis Group were able to embed MBSE into the activities (for example the user requirements elicitation and analysis) that were conducted. The presentation includes an overview of the user requirements elicitation workshops and their outcomes. Following this, a discussion on some of the common themes arising from the workshops is given. Amalgamation of the outcomes of the workshops to potentially develop a common framework for providing technology advice is discussed. Some of the initial system component feasibility exploration is examined, along with the key lessons learned from embedding MBSE into the system development process. Finally, with the increasing use of Model Based Systems Engineering (MBSE) within Defence capability acquisition projects, the potential for this MBSE approach to be used to develop a linkage between a project's knowledge model and simulation performed within DSTO, will be discussed.

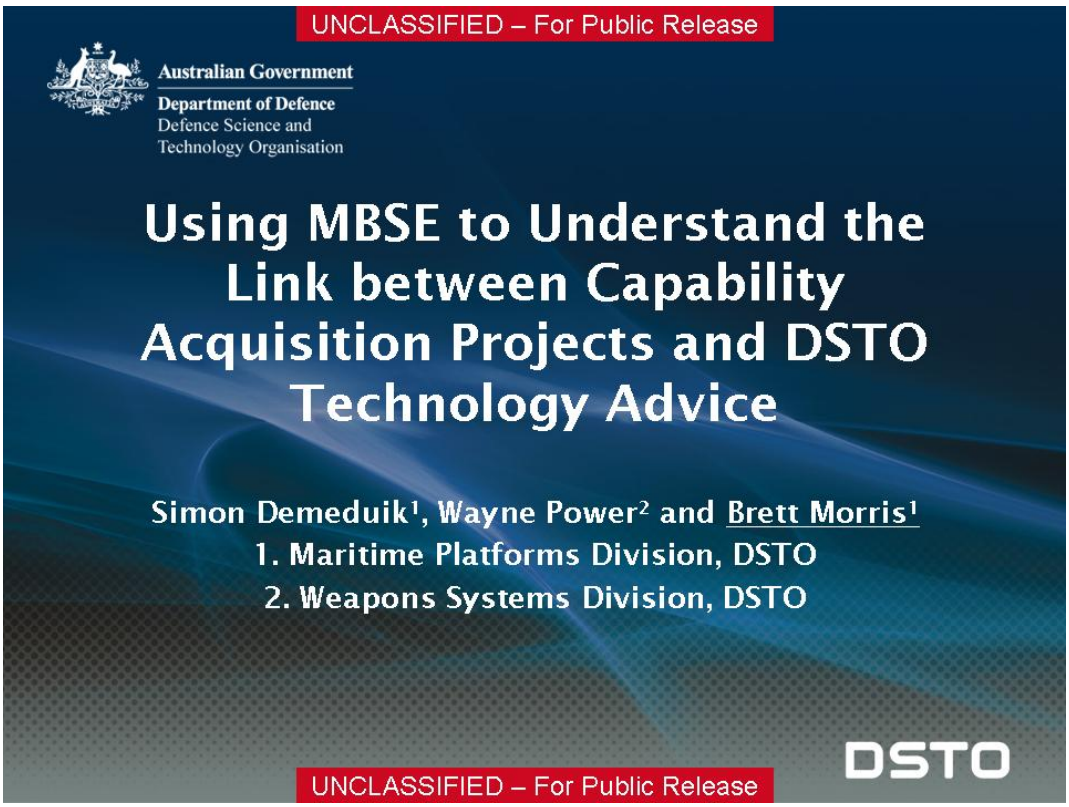
Presenter Biographies

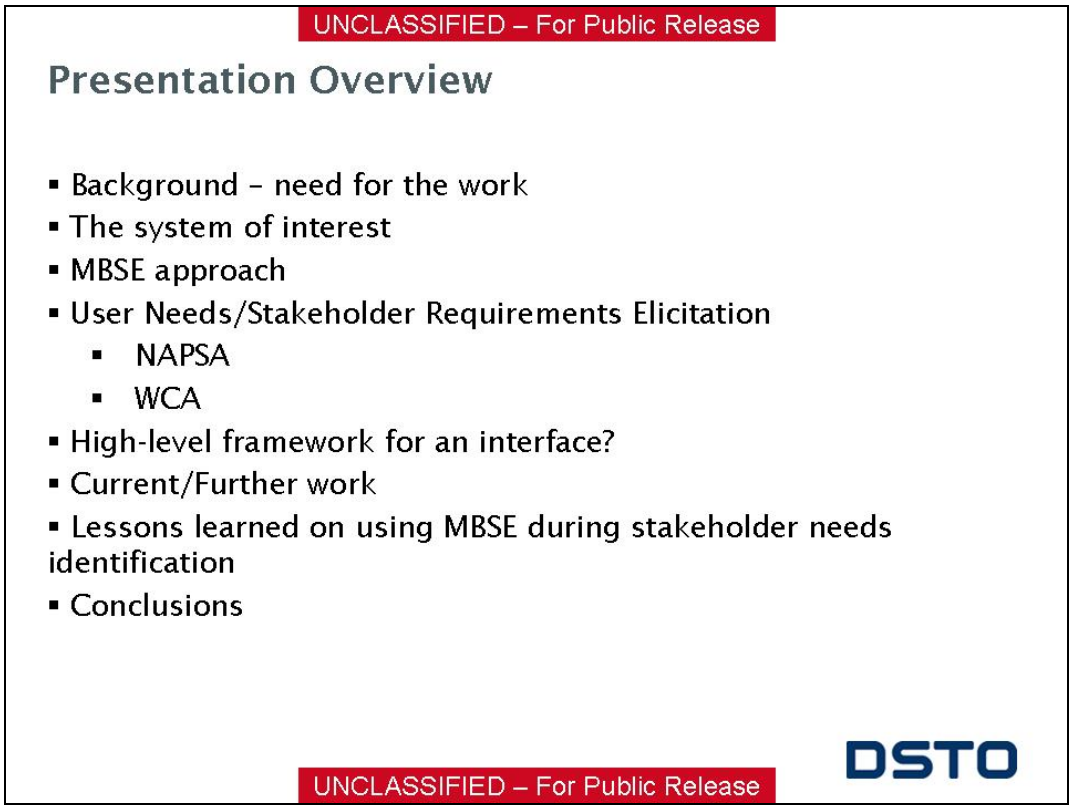
Simon P. Demediuk obtained a Bachelor of Engineering and a Bachelor of Science from Swinburne University in 2009. Since then Simon has worked as a Defence Scientist at DSTO. Simon joined Maritime Platforms Division in 2010 working for the Naval Architecture and Platform Systems Analysis group and currently works on development of analysis tools in relation to the Future Submarine Program.

Wayne Power graduated with honours from the Queensland University of Technology (QUT) with a Bachelor of Engineering (Aerospace Avionics), minor in Systems Engineering. He has spent the last six years working in Weapons Capability Analysis within DSTO's Weapons Systems Division (WSD). His work in WSD has included weapon system integration modelling and analysis, but the major focus of his work has revolved around researching and developing the Whole-of-System Analytical Framework (WSAF). The WSAF employs a Model-Based Systems Engineering approach for the provision of cross-Defence modelling, simulation, analysis and Capability Development activities.

Brett Morris is a Naval Architect/Systems Engineer who joined DSTO in 2007. He has previously worked for the RAN in the Directorate of Navy Platform Systems and is currently working in the fields of Naval ship concept design, structures and hydrodynamics, along with Systems Engineering applications to Naval Architecture. Brett holds a Grad. Dip. In Systems Engineering, a BE (Nav. Arch.) and is currently undertaking part-time research towards a PhD.

Presentation





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Background

- The process linking information request to M&S and advice loosely defined
  - Can lead to:
    - Provision of advice not reflective of request
    - Unrealistic expectations from project
  - Due to:
    - Analysts lacking clarity of purpose
    - Purpose/capability lost in translation
- Group level focus
- Adopted an MBSE approach to System Development
- Is a common framework possible?
- MBSE Capability Models taking off within CDG → Could these be linked to M&S?

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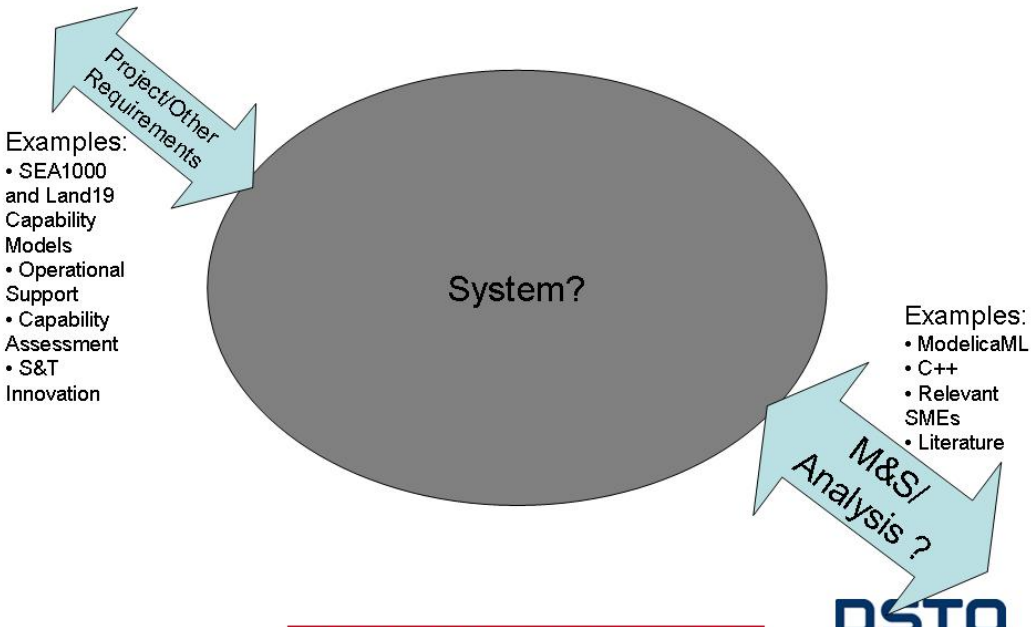
System-of-Interest



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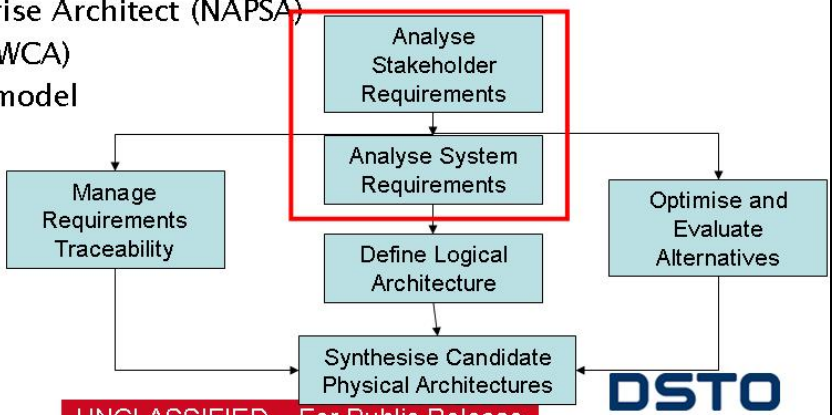
MBSE Approach

- Adopted OOSEM System Specification and Design Process [1] and Systems Engineering Handbook [2] (ISO/IEC15288 [3]) Exploratory Research processes
- Mirrors CDD Process [4] – i.e. operational scenarios to elaborate needs
- Tools
  - Enterprise Architect (NAPSA)
  - CORE (WCA)
- WSAF Metamodel



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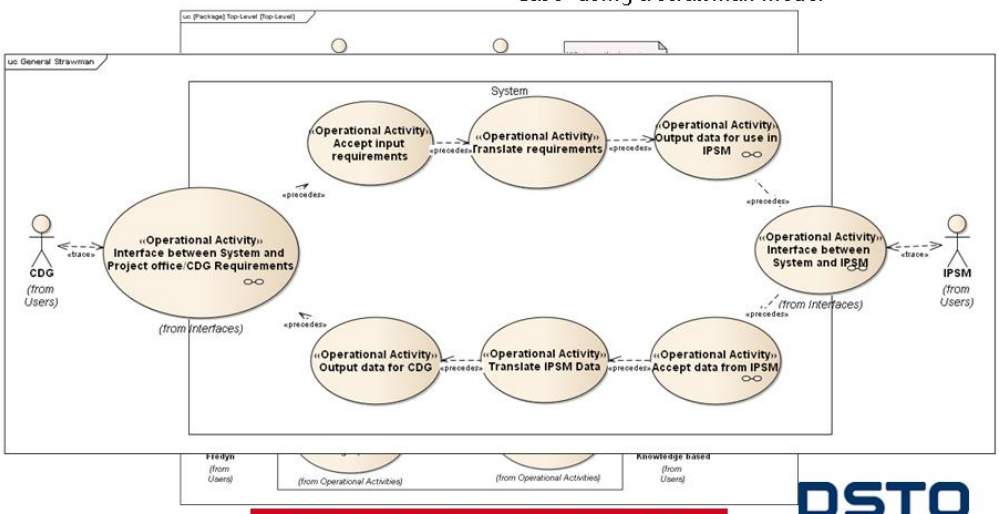
User Needs/Stakeholder Requirements Elicitation – NAPSA Workshop 1

- Outline the session and define MBSE terminology
- Elicit need statement
- Structured Brainstorming
- Minimise "SE" discussion
- MBSE performed on-the-fly
  - Elicit Top-Level "Use cases" (i.e. questions the group has been, or are likely to be asked)
  - Rate the importance of each operational activity
  - Elicited Operational Activities for a general "Use Case" using a strawman model



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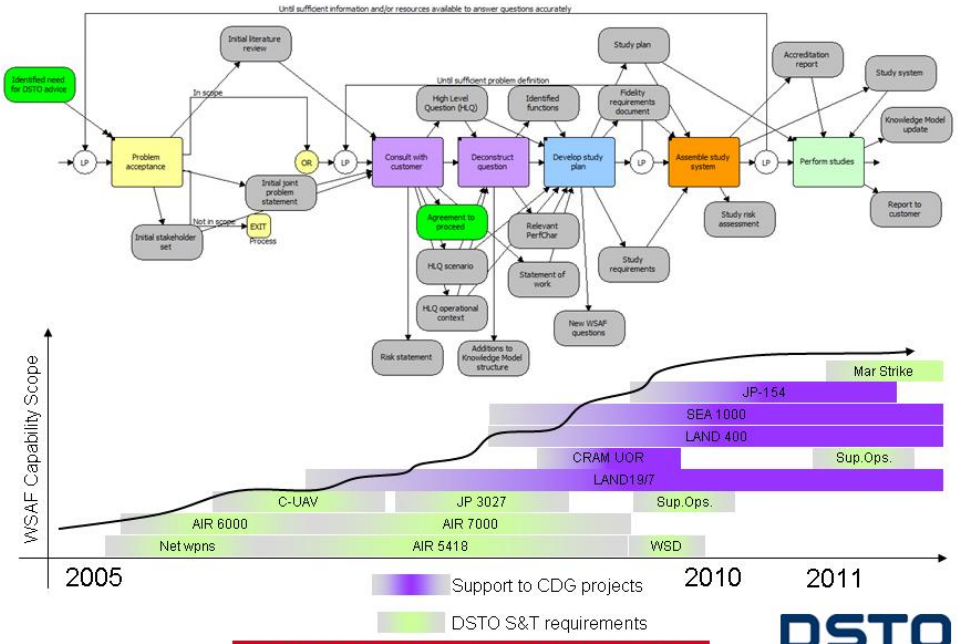
WSAF Evolution



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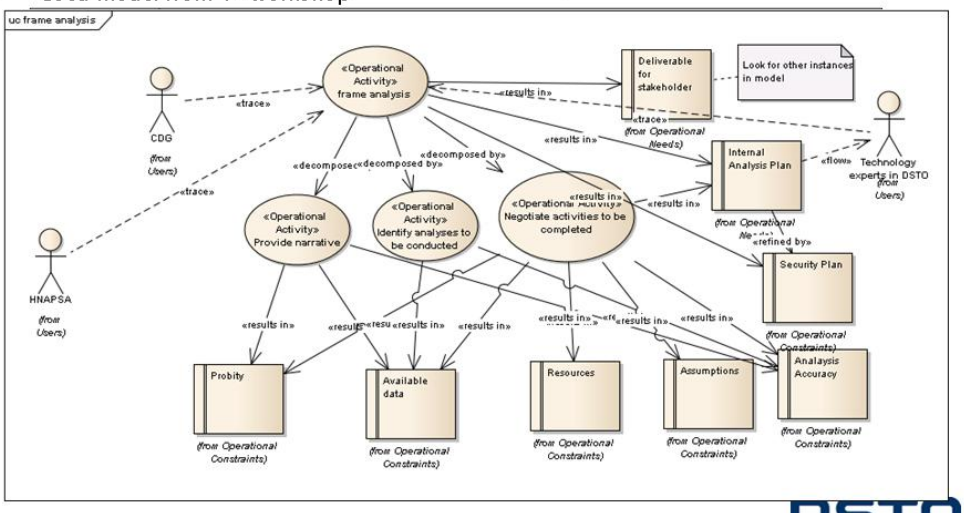
User Needs/Stakeholder Requirements Elicitation – NAPSA Workshop 2

- Similar participants to Workshop 1
- Review of the need statement
- Structured Brainstorming
- Used model from 1st workshop
- MBSE performed on-the-fly
- Elaborated Top-Level Use Case FFBD (operational activities)
- Elicited operational needs and constraints



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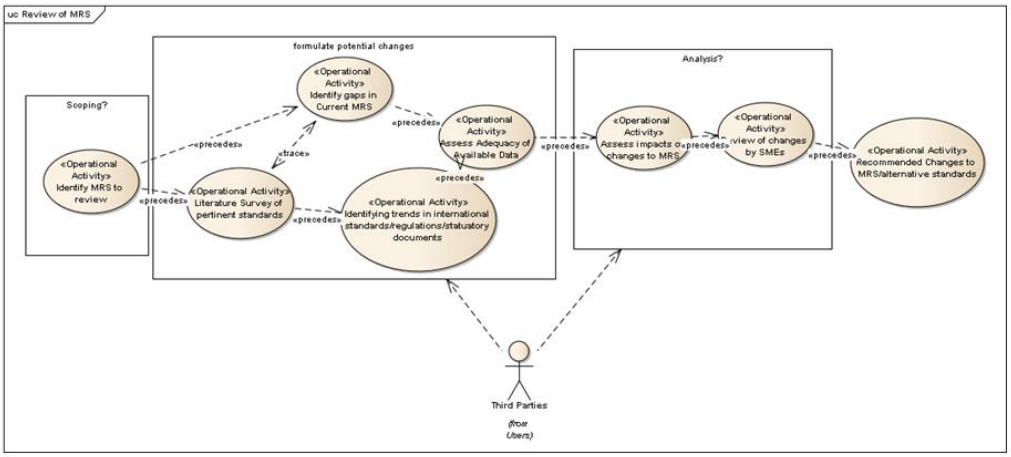
User Needs/Stakeholder Requirements Elicitation – NAPSA Workshop 3

- Elaborated another top-level Use Case
- Blank Canvas
- Restricted participants to 5-8 operational activities



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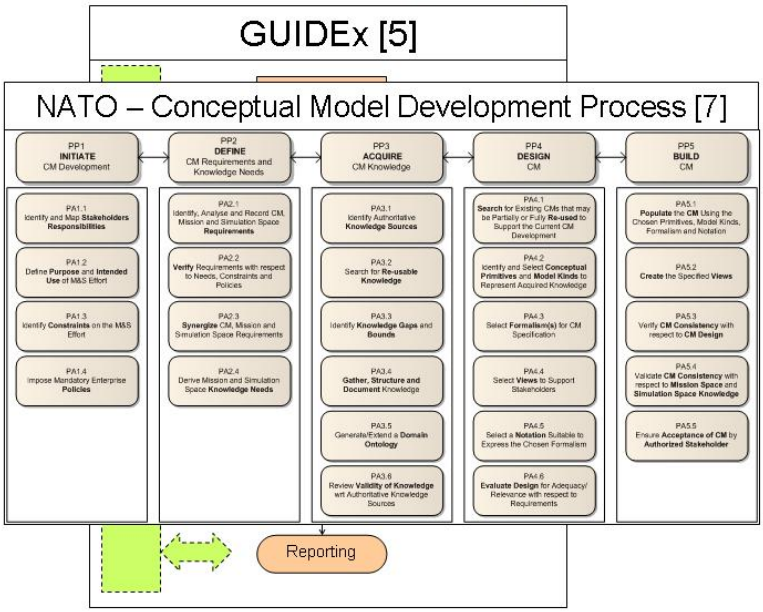
Frameworks for Conducting Analysis



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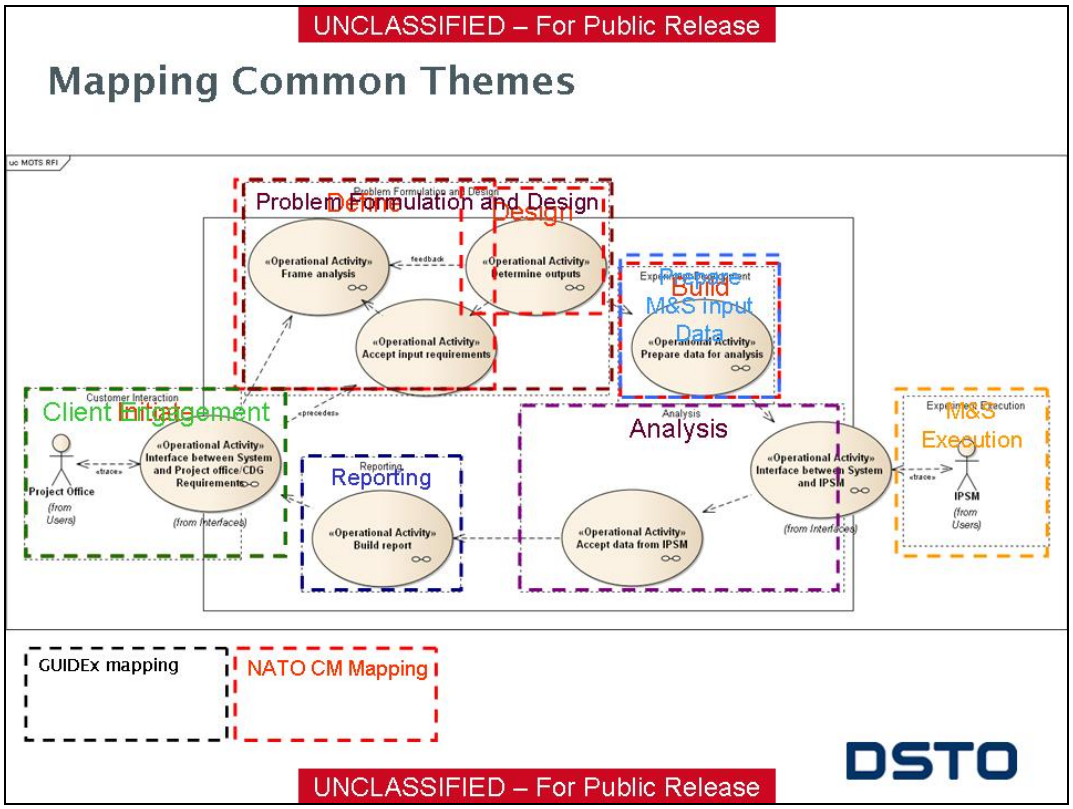
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Mapping Common Themes
Problem Formulation and Design
Define
Design
«Operational Activity» Frame analysis
feedback
«Operational Activity» Determine outputs
«Operational Activity» Accept input requirements
Build M&S Input Data
«Operational Activity» Prepare data for analysis
Client Engagement
Customer Interaction
«Operational Activity» Interface between System and Project office/CDG Requirements
Project Office (from Users)
(from Interfaces)
Reporting
«Operational Activity» Build report
Analysis
«Operational Activity» Accept data from IPSM
«Operational Activity» Interface between System and IPSM
(from Interfaces)
M&S Execution
IPSM (from Users)
GUIDEx mapping
NATO CM Mapping
DSTO
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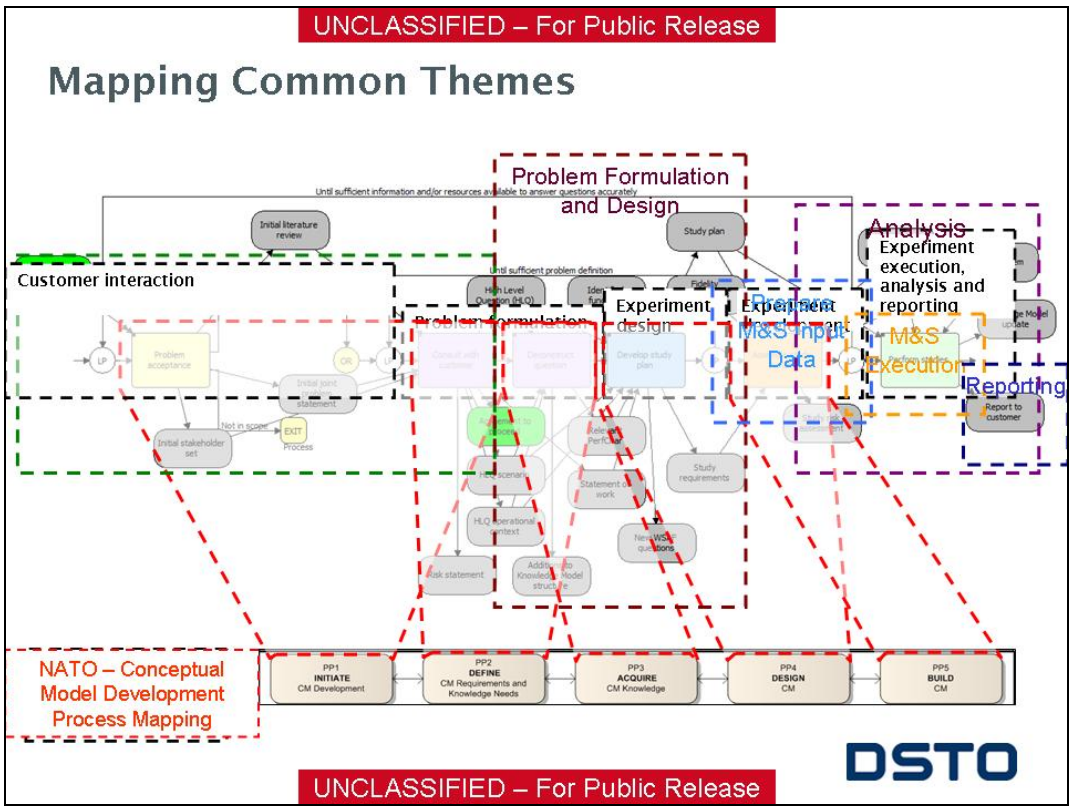
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Mapping Common Themes
Problem Formulation and Design
Customer interaction
Experiment design
Analysis
Experiment execution, analysis and reporting
Build M&S Input Data
M&S Execution
Reporting
NATO – Conceptual Model Development Process Mapping
PP1 INITIATE CM Development
PP2 DEFINE CM Requirements and Knowledge Needs
PP3 ACQUIRE CM Knowledge
PP4 DESIGN CM
PP5 BUILD CM
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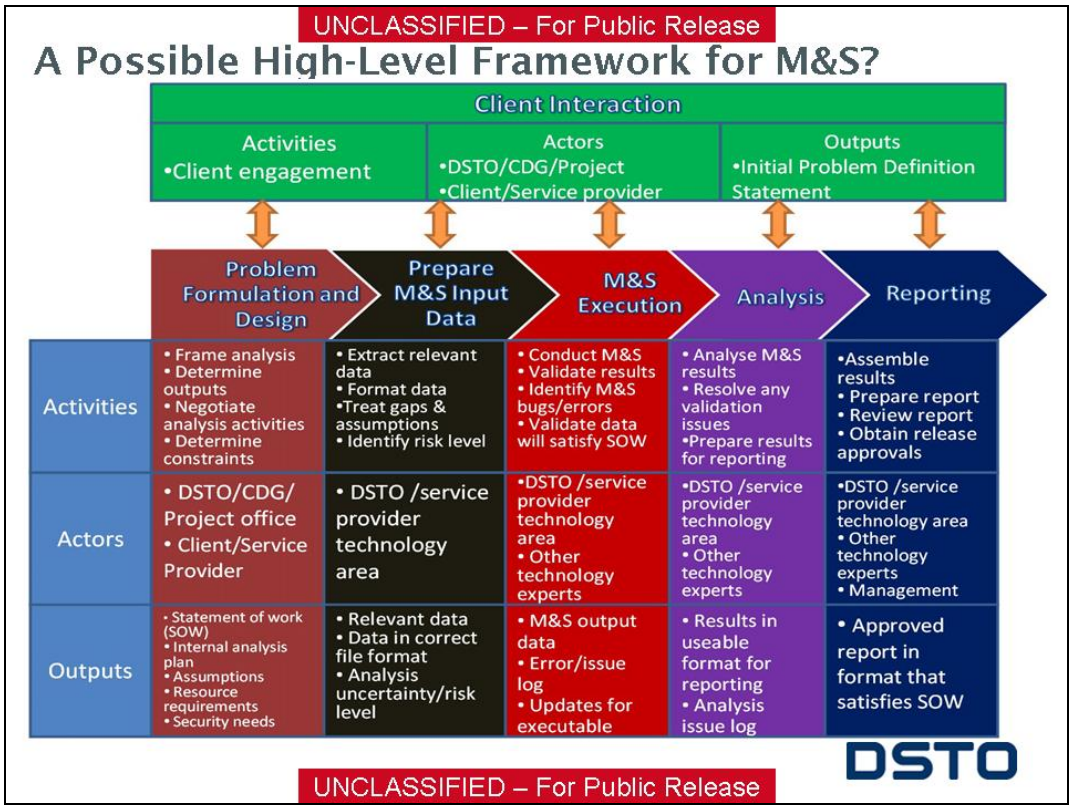
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A Possible High-Level Framework for M&S?
Client Interaction
Activities
•Client engagement
Actors
•DSTO/CDG/Project
•Client/Service provider
Outputs
•Initial Problem Definition Statement
Problem Formulation and Design
Prepare M&S Input Data
M&S Execution
Analysis
Reporting
Activities
• Frame analysis
• Determine outputs
• Negotiate analysis activities
• Determine constraints
• Extract relevant data
• Format data
•Treat gaps & assumptions
• Identify risk level
• Conduct M&S
• Validate results
• Identify M&S bugs/errors
• Validate data will satisfy SOW
• Analyse M&S results
• Resolve any validation issues
•Prepare results for reporting
•Assemble results
• Prepare report
• Review report
• Obtain release approvals
Actors
• DSTO/CDG/ Project office
• Client/Service Provider
• DSTO /service provider technology area
•DSTO /service provider technology area
• Other technology experts
•DSTO /service provider technology area
• Other technology experts
•DSTO /service provider technology area
• Other technology experts
• Management
Outputs
• Statement of work (SOW)
• Internal analysis plan
• Assumptions
• Resource requirements
• Security needs
• Relevant data
• Data in correct file format
• Analysis uncertainty/risk level
• M&S output data
• Error/issue log
• Updates for executable
• Results in useable format for reporting
• Analysis issue log
• Approved report in format that satisfies SOW
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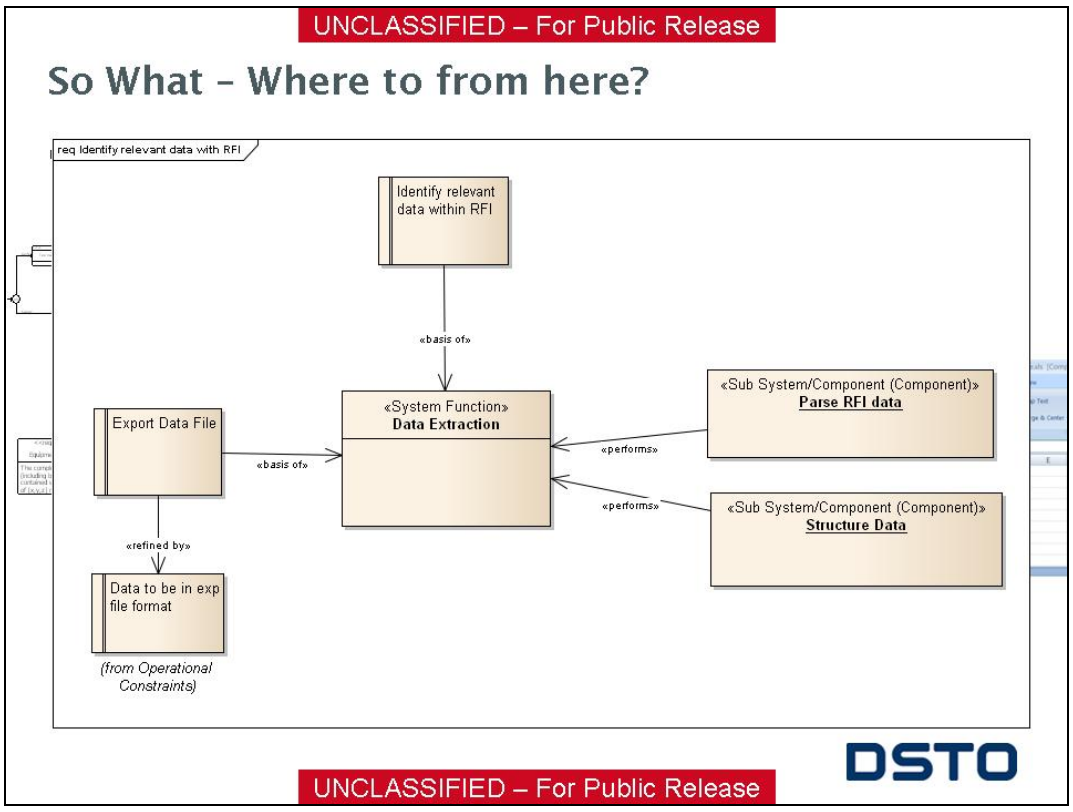
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So What – Where to from here?
req Identify relevant data with RFI
Identify relevant data within RFI
«basis of»
«System Function»
Data Extraction
«Sub System/Component (Component)»
Parse RFI data
«performs»
«Sub System/Component (Component)»
Structure Data
«performs»
Export Data File
«basis of»
«refined by»
Data to be in exp file format
(from Operational Constraints)
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Lessons Learned

- Avoid any emphasis on "we are doing SE"
- Be aware of personalities – e.g.
  - Functional thinking not inherent – give them time to explore
  - People down in the weeds
- Importance of a broad range of stakeholders
- By the third NAPSA workshop, participants had process buy in
  - Positive feedback
  - Able to work with a blank canvas
- Having two facilitators at NAPSA workshops was beneficial
- You can perform modelling on-the-fly – and it aids elicitation!

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Conclusions

- Large amount of Human/negotiating activities within interface
- Possible High-level framework only applicable to Defence/DSTO at present
- MBSE on-the-fly is useful in concept engineering – particularly needs elicitation
- Potential exists to link some of the identified operational activities/functions to components in an interface between MBSE capability models and M&S
  - This is likely to be important with the growing use of MBSE capability models in Defence

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